

Command words

Command words are the words and phrases used in exams and other assessment tasks that tell students how they should answer the question. These are presented in alphabetical order based on the **key word**, not necessarily the first word.

Multiple choice instructions

Circle your answer

No further notes.

Tick (✓) one box

No further notes.

Common instructions

[Comment on the] accuracy [of the model]

Calculate a value using a model, compare it with a value from the real world and write a statement about how closely the values match.

[terms in] ascending powers of x

When you expand a binomial expression of the form $(a + bx)^n$ the expansion must take the form.

$$a^n + \binom{n}{1} a^{n-1}x + \binom{n}{2} a^{n-2}x^2 + \dots$$

Assume

For this part of the question, use the given assumption in any working you do.

[State an] assumption...

In a Mechanics question you should give a relevant modelling assumption such as:

- there is no air resistance
- the surface is smooth
- the string is inextensible.

In other modelling questions, give a relevant modelling assumption.

Calculate

The answer is a number, which you should work out using any appropriate method. You're permitted to use a calculator.

[Use] calculus

In a question asking for a maximum or minimum value, you should use differentiation. In a question asking for the area under a curve, you should use integration.

[Find a/the] Cartesian equation

For a parametric equation, eliminate the parameter and express the equation in terms of x and y .

[By considering a suitable] change of sign, show that...

Use the sign change rule.

You must define a function which you evaluate at each endpoint of the interval and compare the values explicitly with zero.

eg $f(a) > 0$, $f(b) < 0$.

[Find the] coefficient of...

In a binomial expansion your final answer should just be the coefficient of the required term.

For example, in the expansion of $(1 + 2x)^5 = 1 + 10x + 40x^2 + \dots$ the coefficient of x^2 is 40.

Compare/give a comparison...

You must write about both items being compared and state a similarity or difference.

It's not unusual to see comparisons that say, for example, 'The median of CO emissions is higher for cars registered in 2002.' Whilst the word 'higher' implies a comparison, there is no clear identification of what 'cars registered in 2002' are being compared with. It's not enough that this is given in the question: you must state it in your comparison.

[State...assumptions in] context

Your assumptions must relate to the real world context of the question, eg if considering whether a binomial model is appropriate, you will consider whether the probability of success is constant, or the trials are independent, and you must refer to the real world when doing so.

[By using a] counter example...

Use any appropriate counter example to demonstrate that a result is incorrect.

...curve, C

We often refer to a curve by a letter so that we can then refer to it again easily.

We might say, for example, 'Sketch the graph of C ' or 'Show that C does not intersect the y -axis.'

Deduce

The answer can be worked out by a little thinking, but probably not very much working out. If you need to do some working out, you can do so.

Describe

Write the required information using correct mathematical vocabulary.

Determine whether...

The statement could be true or false. Give a reason to explain which it is.

Differentiate from first principles

Use the formula given in the Formulae booklet to find $\frac{dy}{dx}$.

Write down the formula as given below and then substitute into it.

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

In all other situations, differentiation is not expected to use the first principles method.

[State a] distribution which could model...

The distribution will be either binomial or normal.

State the correct model for the discrete random variable and give values for its parameters i.e. $X \sim B(n, p)$ or $X \sim N(\mu, \sigma^2)$.

[Find the] domain of...

Write down the domain of the function, using set notation or interval notation.

[State the maximum possible] domain of...

The definition of a function will be given. There will be some values of x for which the function is undefined.

The maximum possible domain is the set of real numbers, \mathbb{R} , with these values removed.

[Find an/the] equation of...

An equation of a line or circle (or any other curve) may be given in any form, unless a question specifies a particular form.

[Form an] equation of motion...

Use Newton's 2nd law, $F = ma$, to write down an equation for the motion of a particle.

When working with connected particles and the motion is not in a straight line, you must form separate equations of motion for each particle.

Forming an equation of motion for the whole system is considered an invalid method and would lead to few or no marks.

Estimate

Use the given information to work out the answer: this is typically done using a mathematical model to calculate a value.

In this case it is good practice to use/give the exact answer of any calculation and then round the final answer to a sensible degree of accuracy.

...exact...

The required value should be given as a fraction, surd or in terms of \ln or e as specified in the question.

A rounded value obtained from a calculator would not gain full marks.

[Show that] ...exactly...

In a question such as 'Show that $y = \frac{e^{3x}-5}{x^2}$ has exactly one stationary point', you must show not just that there is a stationary point, but that it is the only one.

Explain

Use appropriate mathematical vocabulary or notation to answer the question.

Expand

For a binomial expansion all terms must be simplified.

Evaluate

The answer is a number, which you should work out using any appropriate method. You're permitted to use a calculator.

A definite integral may be found using a calculator.

Express

Give the answer in a particular form as specified in the question.

This could be used for writing an expression in partial fractions or for giving one variable in terms of another.

[Use the] factor theorem...

Show the correct substitution into the polynomial $p(x)$ and give the correct value of the function, concluding correctly that the proposed factor is or is not a factor of $p(x)$.

Factorise

Express a polynomial as a product of a constant, if applicable, and irreducible linear and/or quadratic factors.

The factorisation must always be full even if the word "fully" or "completely" is not included in the question.

Find

Give the value required. Typically, no working is necessary if a question is worth 1 mark.

If the question is worth more marks, then a correct answer with no working will still gain all marks, but working out will typically be seen.

Find f (or f^{-1})

Find both $f(x)$ (or $f^{-1}(x)$) and its domain.

Fully justify your answer

Any reasoning to reach the required conclusion should be explicitly stated in the solution.

This does **not** imply that routine calculations must be done without a calculator.

[In this question use] $g = 10 / 9.8 / 9.81 \text{ ms}^{-2}$

You should be aware that there are three standard values used for the acceleration due to gravity, given to 1, 2 or 3 significant figures. Your answer to any question in which a value of g is used should be given to the same accuracy as the value of g .

Give

This command word is used often.

When referring to a value, it just means write down.

When referring to a comment, take care to focus on precisely what is being asked and use mathematical vocabulary in your answer.

Give one advantage/disadvantage...

This implies that a comparison is needed, so take care to mention both items which are being compared.

Give a/one reason why...

Write down a reason; typically, no further calculation is expected, but you could do more working if you need to.

Give your answer in the form...

Your final answer must be written in the specified form to gain the final mark for this question.

When asking you to do this, the examiner is testing your skills of algebraic manipulation.

Give your answer to the nearest...

The accuracy stipulated is usually to guide you so that you do not have to choose how to round an answer. Answers to a greater accuracy are not necessarily penalised, but answers to less accuracy do not gain full marks.

[It is] given...

This indicates that you are being told some information vital for the question and we prefer to put this in a sentence, rather than just writing down a mathematical statement.

For example, we would write:

Given that

$$6 \cos \theta + 8 \sin \theta \equiv R \cos(\theta + \alpha)$$

find the value of R .

We could have omitted 'Given that' but the question is better with it there.

Hence

Use the result from the previous part of the question.

The use of any other method will typically lead to fewer or no marks being given.

[Carry out a] hypothesis test at the x% significance level

You should:

- state null and alternative hypotheses using correct notation for the parameter being investigated
- state the distribution being used (if relevant)
- calculate an appropriate probability or identify a critical region
- compare the test statistic with the critical region or the probability with the significance level
- state 'Do not reject H_0 ' or 'Reject H_0 '
- reach an appropriate conclusion in context, typically using the wording: 'There is/is not significant evidence to suggest...' and then repeating the claim made in the question.

Identify

This is often used in multiple choice questions, but can be used in other short questions.

It means that you should select from a choice and usually no working is expected.

You might have to identify where in a proof or solution given in the question a mistake arises and you need to write down where it is.

[Use] integration by substitution...

In many cases, no substitution will be given and you should choose an appropriate one to use.

If a substitution is given, it should be used.

Other methods will not receive full marks.

Interpret...in context

Your answer to the question should be related to the real-world context in which it is set.

For example, the value of $\frac{dV}{dt} = 0.15$ would be interpreted as the volume is increasing at a rate of $0.15\text{m}^3\text{s}^{-1}$.

[Explain why the model is] invalid

Compare the mathematical model with the real situation it is modelling and explain why the maths does not fit with reality (eg, if a model predicts a negative value for the mass of a substance, the model would be invalid at this point).

Investigate, at the x% significance level, whether...

Carry out a hypothesis test.

[Using your knowledge of the] Large Data Set

You are expected to have used the Large Data Set (LDS) and be familiar with the types of data it contains. This will give you an advantage in answering this question that someone who has not used the LDS will not have.

[Find the] maximum/minimum

If calculus is used, there should be a statement that the maximum/minimum value occurs when $f'(x) = 0$. The nature of the stationary point should be determined using $f''(x)$ with a clear comparison with zero.

[Use the] Newton-Raphson method...

No working out is required to be shown, because the formula may be entered directly into a calculator.

However, writing down the formula with an expression for $f'(x)$ would gain credit if answers were wrong.

Plot

Draw an accurate graph, on the grid provided, marking each point with a cross.

Prove

Give a formal proof with each step shown.

The mathematical argument should be rigorous.

The proof should contain a final concluding statement saying what has been proved.

Prove by contradiction...

The method of proof by contradiction must be used.

Other methods are unlikely to gain marks.

[Find the] range of...

Write down the range of the function, using set notation or interval notation.

Show that...

Give every step of a process that will lead to the required outcome.

The solution should contain a concluding statement which states what has been shown.

Simplify

An algebraic answer should be simplified as much as possible.

For example:

- an algebraic fraction should have all common factors in numerator and denominator cancelled
- an expression should have all coefficients expressed as simply as possible eg $-2x \times 3 \sin 3x$ should be written as $-6x \sin 3x$
- all like terms should be collected together.

[Express as a] single logarithm

The answer should be of the form $\log_a f(x)$ or $\log_a b$.

Sketch

Give a depiction of a graph where the important features are identified.

Typically, a sketch will show the values at which the graph intersects the axes, if little or no calculation is needed to find these values.

Asymptotes are best drawn as dashed or dotted lines so that the curve can be clearly shown to be asymptotic.

The turning point of a quadratic should be in the correct quadrant.

[Using] small angle approximations...

Use $\sin x \approx x$, $\tan x \approx x$ and $\cos x = 1 - \frac{x^2}{2}$ to show the required result.

Solve

Find the value(s) that satisfy a given equation or inequality.

State

Write the required information using correct mathematical vocabulary.

[Find the] stationary/turning points and state its/their nature

If calculus is used there should be a statement that the stationary/turning points occur when $f'(x) = 0$.

State the nature of each stationary/turning point: is it a maximum, minimum or stationary point of inflection.

Use the graph to...

You should get your answer from the graph rather than from calculation.

Verify that...

Use an appropriate calculation to show that the given statement is true.

Write down...

The answer should be obtainable from the information given, so no working out should be needed.